UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/873,041	06/01/2001	Michael Heuken	03345-P0017A	5097

24126 7590 11/03/2005

ST. ONGE STEWARD JOHNSTON & REENS, LLC
986 BEDFORD STREET
STAMFORD, CT 06905-5619

EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1722	

DATE MAILED: 11/03/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/873,041	HEUKEN ET AL.
	Examiner	Art Unit
	Matthew J. Song	1722

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 August 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-59* is/are pending in the application.

4a) Of the above claim(s) *18,26-28 and 57-59* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17, 19-25 and 29-56* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

(P

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/16/2005 has been entered.

Status Identifiers

2. Claims 57-59 use the status identifier of "previously presented", however these claims were withdrawn from examination by the Examiner, previously, note the office action dated 5/5/2004. The correct identifier is "withdrawn". Appropriate corrections are required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 1, 23, and 30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites, "calculating at lest one gradient between a set of temperature, the set of temperature selected from the group consisting of the temperatures of the gas outlet and the wafer supports, the temperatures of the gas mixing system and the gas inlet,

and the temperatures of the upper side of the reaction chamber and the first wafer support" in lines 21-25. It is unclear how this calculation is used in the instantly claimed invention because the controlling of the plurality of temperature is performed using the determined plurality of temperature and the determined at least one temporal variation in correspondence with a plurality of numerically simulated temperature variation profiles, note lines 26-29 of claim 1. It is unclear how the invention is further limited because the calculation of the gradient does not affect the process since the calculated gradient is not used to control temperature.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 1-10, 12-17, 19-25, and 29-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schmitz et al ("MOVPE growth of InGaN on sapphire using growth initiation cycles") in view of Burmeister (US 3,617,371) and de Waard et al (US 6,373,033) or Stoddard et al (WO 98/35531).

Schmitz et al discloses a Metal organic chemical vapor deposition, MOCVD, for forming an AlGaInN alloy, where a variety of total flow rates and extremely precise temperature control and uniformity across the entire reactor and the substrate by means of a new multicoil heater system are used to achieve a film with excellent photoluminescence uniformity, this reads on applicant's controlling process parameters in the reaction chamber (Abstract). Schmitz et al also discloses an inductive heater brings a susceptor to a maximum temperature of 1600°C and very fast heat up and cooling cycles up to 6°C/sec can be achieved. Schmitz et al also discloses rapid cooling rates are enhanced because of reduced thermal mass susceptor, water cooled reactor chamber with all thermostated reactor walls. Schmitz et al also discloses reagents are separated in two carrier gas flows that combine at the injector and thermal management of the reactor in particular is a very critical parameter. Schmitz et al also discloses the injection zone is kept at a lower temperature to preserve less stable compounds (col 2-3), this reads on applicant's gas inlet. Schmitz et al also discloses accurate heat transfer calculation are critical because precursor decomposition and formation of deposits are determined by the temperature distribution in the MOCVD reactor. Schmitz et al also discloses precise temperature control of a quartz ceiling, this reads on applicant's upper side of the reaction chamber, inside the reactor is employed to keep the inner reactor wall, this reads on applicant's chamber walls, at a suitable elevated temperature to minimize deposits and growth temperatures are adjusted with a precision of 0.1°C. Schmitz et

al also discloses total flow rates and the gas flow ratio are used to optimize the growth rate and uniformities while growth rates can be adjusted independently (col 4-5). Schmitz et al also discloses absolute control over the ceiling temperature by employing an in situ monitoring and closed feedback control system and a sensor from 400 to 1900°C with a resolution to 0.1 °C is used, this reads on controlling the temporal variation of the set of process temperatures, and it is possible to monitor the temperature profile of the wafer, satellite and planetary disc and a RF heater is adjustable such that the temperature uniformity of the satellite and planetary disc is optimized, this reads on applicant's first and second wafer support (col 9-12). Schmitz et al also discloses a multiwafer planetary reactor with a rotating susceptor and an exhaust (fig 1).

Schmitz et al does not disclose a gas mixing system.

In a method of growing a III-V layer by vapor phase epitaxy, note entire reference, Burmeister teaches a vapor phase reactor includes separately arranged source, mixing **45** and growing chambers which may be selectively heated inductively to eliminate contaminating decomposition of the reactor walls (col 1, ln 1-67). Burmeister also teaches RF heating coils **65** may be varied to concentrate the heating power at selected portion of the length of the walls and the portion adjacent the mixing chamber operates at approximately 800°C and the term approximately is intended to include values within + 10 percent of the stated value. Burmeister also teaches a temperature sensing means **71** may be connected to a thermocouple **69** for giving a temperature indication or for controlling the RF power from source **67** where desired to maintain close control of operating temperature (col 2, ln 1-75). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Schmitz et al with Burmeister's mixing chamber to eliminate contaminating decomposition of the reactor walls (col 1, ln 25-40).

The combination of Schmitz et al and Burnmeister et al does not teach controlling the temporal variation of at least one process temperature in correspondence with a numerically simulated temperature variation profile.

In a method of model based predictive control of thermal processing used in semiconductor processing (col 1, ln 10-20), de Waard et al teaches a temperature controller uses the process model to calculate a predicted temperature output over a predetermined future time period. de Waard et al also teaches the model is based on a polynomial model, this reads on applicants' numerical simulated temperature variation profile (col 9, ln 35 to col 10, ln 67). de Waard et al also teaches the temperature controller also comprises a control calculator that uses the predicted nominal temperature output to calculate an optimum strategy by which to control the source of thermal energy (col 4, ln 25-67 and col 36, ln 15-67), this reads on applicants' controlling at least one process temperature and temporal variation thereof in correspondence with a numerically simulated temperature variation profile. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz et al and Burnmeister et al by controlling the process temperatures in correspondence to a numeric simulation, as taught by de Waard et al, because de Waard et al method is more effective control system and has improved controller response time (col 9, ln 50-65 and col 4, ln 25-35).

In a method of controlling a thermal reactor, Stoddard et al teaches using a least squares parameter estimation algorithm to obtain estimates of the system parameters which reflect temperature response characteristics and controller design employs high performance numerical software, such as MATLAB (pg 22), this reads on applicants' numerical simulated temperature

variation profile. Stoddard et al also teaches an on-line model predicts wafer temperature and a plurality of selectable control mode logic circuits which control the heating element in response to the online model (pg 9), this reads on applicants' controlling at least one process temperature and the temporal variation thereof in correspondence with a numerically simulated temperature variation profile. Stoddard et al also teaches using the temperature controller to grow or deposit material on the surface of silicon wafer and using a low pressure chemical vapor deposition process (pg 16). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz et al and Burnmeister et al by controlling the process temperatures in correspondence to a numeric simulation, as taught by Stoddard et al, because using models provide an accurate indication of temperature during dynamic changes in temperature, thereby improving control (pg 20, ln 15 to pg 21, ln 5).

Referring to claims 1, 23 and 30, the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al does not teach calculating at least one gradient between a set of temperatures, the set of temperatures selected from the group consisting of the temperatures of the gas outlet and the wafer supports, the temperatures of the gas mixing system and the gas inlet, and the temperatures of the upper side of the reaction chamber and the first wafer support. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al by calculating the temperature gradient between the set of the claimed temperatures, which can be easily determine using the temperatures measurements and control unit, to ensure uniform conditions throughout the reactor.

Referring to claims 2 and 35, the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al does not teach controlling the temperature T_1 below the condensation temperature of the gases and by adjustment of the temperature for avoiding the formation of addition compounds. Schmitz et al discloses the injection zone is kept at a lower temperature to preserve less stable compounds (col 2-3). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al by injecting the reactants at a temperature below the condensation temperature to preserve less stable compounds, which would also avoid formation of addition compounds.

Referring to claims 3 and 36, the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al teach all of the limitations of claim 3, as discussed previously, except control of temperature T_2 as equal to the temperature of T_3. Schmitz et al teaches the precise control of the quartz ceiling inside the reactor is employed to keep the inner reactor wall at a suitable temperature (700-950°C), which allows to minimize deposits (col 5). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al to have the principle wafer support equal the temperature of the chamber wall to minimize the deposits of the wafer support. Furthermore, temperature is a result effective variable that can be optimized through routine experimentation (MPEP 2144.05).

Referring to claims 4 and 37, Schmitz et al discloses an inductive heater brings the susceptor to a maximum temperature of 1600°C and heat-up and cooling cycles up to 6°C/sec (360°C/min) can be achieved (col 2-3) and it is necessary to hold temperature constant for good quality epitaxial layers (col 10).

Referring to claims 5 and 38, Schmitz et al disclose a sensor with a resolution to 0.1°C is used and it is possible to monitor the temperature profile of the wafer, satellite and planetary disc and adjusting the heater such that the temperature uniformity of the wafer and satellite disc is optimized, this reads on applicant's controlling the temperature of the individual wafer supports, satellites, in correspondence to the temperature T_3, the planetary disc.

Referring to claims 6 and 39, the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al teach all of the limitations of claim 6, as discussed previously, except controlling the temperature of T_5 to a value smaller than the value of the temperatures T_4 and T_5. The temperature of the wafer supports requires a large amount of heat for decomposition of reactant gases and deposition, but the gas outlet does not have this requirement because no deposition is desired at the gas outlet; therefore it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al by heating the gas outlet to a temperature less than T_4 to save energy and reduce operating costs. Also temperature is a result effective variable, which can be optimized through routine experimentation (MPEP 2144.05).

Referring to claims 7 and 40, Schmitz et al teaches the reagents are separated in two gas flows that combine at the injector and the injection zone is kept at a lower temperature to preserve less stable compounds (col 3).

Referring to claims 8-9 and 41-42, Schmitz et al discloses it is necessary to hold the ceiling, the upper side of the reaction chamber, temperature constant to be sure about the thermal condition of the susceptor surface and wafer, this reads on applicant's correlates to T_3 (col 10). The closed feedback control system, this reads on applicant's heating system, provides control over the ceiling temperature.

Referring to claims 10 and 43, Schmitz et al discloses total flow rates are used to optimize growth rates and uniformities can be adjusted independently, this reads on applicant's controlling a temperature dependent gas flow variation (col 5).

Referring to claims 12 and 45, Schmitz et al discloses controlling a temperature dependent principle carrier gas variation in the reaction chamber (Fig 6).

Referring to claims 13 and 46, Schmitz et al discloses controlling temperature GaN/InGaN growth (Fig 17) during substrate cleaning, nitridization, buffer layer growth and film growth, this reads on applicant's controlling temperature dependent interrupts in the production process because production is interrupted between layers and temperature control is maintained.

Referring to claims 14 and 47, Schmitz et al discloses substrates of Al_2O_3, SiC and Si, this reads on applicant's other material resistant to temperature and process gases.

Referring to claims 15 and 48, Schmitz et al discloses substrate cleaning and nitridization and growing a buffer layer (col 17), this reads on applicant's surface treatment or covering the surface with other materials or material components.

Referring to claims 16 and 49, Schmitz et al discloses growing a buffer layer at 500°C and growing GaN at 1000-1100°C using ammonia and trimethyl gallium (col 15 and col 17), this reads on applicant's two stage application of materials.

Referring to claims 17 and 50, Schmitz et al discloses the injection zone is kept at a lower temperature to preserve less stable compounds, this reads on applicant's temperature controlled injector.

Referring to claims 19-20 and 51-52, Schmitz et al teaches an inductive heater brings a susceptor, this reads on applicant's first wafer support, to a maximum temperature of 1600°C and very fast heat up and cooling cycles up to 6°C/sec (360°C/min) can be achieved. Overlapping ranges are held to be obvious (MPEP 2144.05).

Referring to claims 21 and 53, Schmitz et al teaches growth temperatures are adjusted with a precision of 0.1°C.

Referring to claims 22 and 54, the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al is silent to the temperature of the second wafer support is less than the temperature of the first wafer support. The first wafer support is in contact with the susceptor and the second wafer support is on top of the first wafer support. The second wafer support is inherently lower temperature because there is inherently some heat lost do to heat transfer. Furthermore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz,

Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al by optimizing the temperature of the first and second wafer supports to obtain same by conducting routine experimentation of a result effective variable because changes in temperature are held to be obvious (MPEP 2144.05).

Referring to claims 24-25 and 55-56, Schmitz et al teaches p-type and n-type doping (pg 236) and a concentration of 10^{17} cm^{-3}, this reads on applicant's up a concentration of 10^{18} cm^{-3}. Furthermore, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. (In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235(CCPA 1955)). Changes in concentration is held to be obvious, note MPEP 2144.05.

7. Claims 11 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schmitz et al ("MOVPE growth of InGaN on sapphire using growth initiation cycles") in view of Burmeister (US 3,617,371) and de Waard et al (US 6,373,033) or Stoddard et al (WO 98/35531), as applied to claims 1-10, 12-17, 19-25, and 29-56 above, and further in view of Takai et al (US 5,402,748).

The combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al teaches all of the limitations of claim 11, as discussed previously, except additionally controlling a temperature dependent total pressure variation in the reaction chamber.

In a method of growing a semiconductor film, note entire reference, Takai et al teaches a GaAs buffer layer **22** is grown on a Si substrate **21** while supplying TMG and AsH_3 and the

supply of TMG is interrupted and the temperature is elevated to about 650°C while controlling the total pressure of AsH_3 (col 8, ln 35-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Schmitz, Burmeister and de Waard et al or the combination of Schmitz, Burnmeister and Stoddard et al with Takai et al to control the total pressure to guarantee satisfactory flatness in the surface of a layer on top of the buffer layer (col 8, ln 50-67).

Response to Arguments

8. Applicant's arguments with respect to claims 1-17, 19-25 and 29-56 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Frijlink (US 5,108,540) teaches a device **20** for controlling the temperature of wall opposite a susceptor.

Flemish et al (US 5,256,595) teaches a hot wall reactor with four temperature zones for deposition, mixing, preheating and injection, where gas flows are controlled by a microprocessor (col 2-3).

Molnar (US 6,086,673) teaches exhaust lines are at a sufficiently high temperature to prevent clogging reactor exhaust lines (col 4, ln 55-67).

Suzuki (US 5,593,608) teaches an improved temperature control method using a feed-forward temperature control method and a feed forward signal is generated by simulation (col 2, ln 50-67 and col 13, ln 1-15).

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Duane Smith can be reached on 571-272-1166. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1722

MJS
October 28, 2005

ROBERT KUNEMUND
PRIMARY EXAMINER